Diffusion Imaging at 3.0T with Sensitivity Encoding: Intra-individual comparative clinical study

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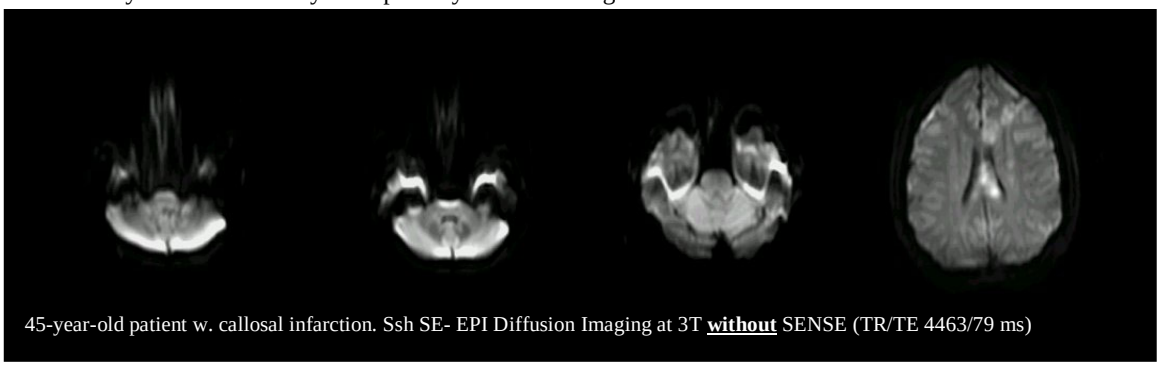
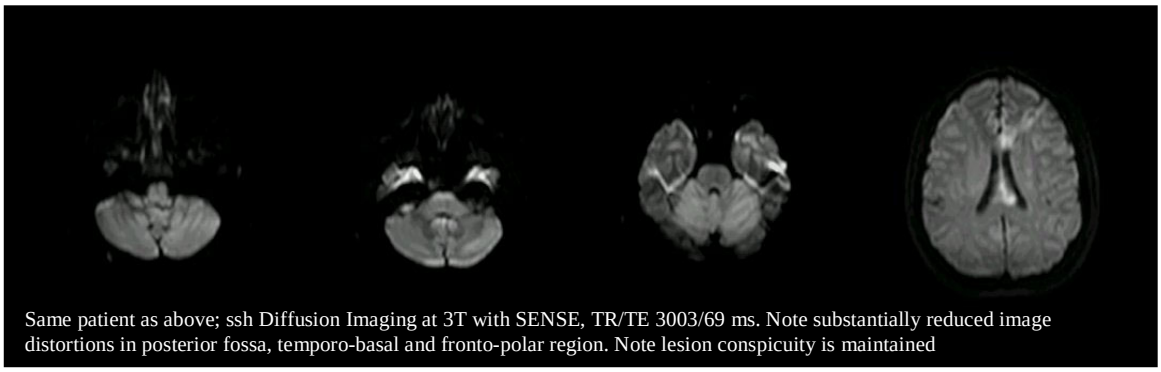
Introduction: Diffusion imaging (DI) has become the cornerstone for the timely diagnosis of ischemic lesions in patients presenting with clinical symptoms of acute stroke. Still, at 1.5T, diffusion imaging suffers from poor SNR. Moving from 1.5T to 3T significantly improves SNR and, most importantly, lesion CNR, which may help improve sensitivity for subtle ADC changes, e.g. owing to small embolic infarction. On the other hand, DI at 3T suffers from substantial image distortions, because susceptibility effects increase with increasing field strength. A disadvantage of DI at 3T compared to 1.5T is, therefore, a probably reduced diagnostic yield secondary to image distortions that arise in particular in the posterior fossa, brain stem, frontobasal and temporobasal regions. An efficient approach to reduce susceptibility artifacts is by reducing echo train length in single shot diffusion imaging. This can be achieved by using parallel imaging techniques such as SENSE (Sensitivity Encoding). We performed an intra-individual comparative trial to investigate the impact of parallel imaging (SENSE) for diffusion imaging (DWI) at 3T in terms of image quality and presence of artifacts, SNR, CNR, and clinical reading of DWI studies in 85 patients presenting for work-up of suspected ischemic stroke.

Materials and Methods:
Prospective intra-individual comparative study on 85 patients who underwent diffusion imaging on a 3T whole body MR system (Intera 3.0T, Philips Medical Systems) twice, with and without Sensitivity Encoding (SENSE). A 6-element SENSE-compatible surface coil was used; the system´s built-in body coil served for RF transmission and for generation of the coil sensitivity reference scan. Ssh EPI DWI with regular phase encoding and SENSE were done with identical geometric parameters:128x128 imaging matrix, 24 sections, 4 mm thick, 2 b-values (0, 1000); TE/TR at regular DWI 79/4462 ms; SENSE-DWI with Sense Factor of 3 translated into a reduced TE and TR: 69/3141. Image quality and conspicuity of ischemic lesions were rated by 2 neuro-radiologists, diagnostic confidence in demonstrating and excluding ADC lesions were compared for the SENSE-DWI and regular DWI. Lesion CNR and overall image SNR were quantified. The Wilcoxon matched pairs signed ranks test and paired Student´s t-test were used to test for statistical significance.

Results: A substantial reduction of image distortions was noted on the diffusion images with SENSE. This was particularly true for the areas close to the skull base or to the skull convexity. In addition, in-plane blurring was significantly reduced with SENSE. Probably due to the SNR gain brought about by the shorter TE and TR, the SENSE-attributable SNR loss seemed more than compensated for. There were a total 48 ADC lesions identified in 24/85 patients. No statistically significant differences regarding lesion-to-normal tissue CNR was found. Yet, due to the significantly reduced image distortions, lesion consipcuity was rated consistently (and, thus, significantly) higher in the SENSE-DWI compared to regular DWI. This translated into a significantly higher diagnostic confidence in demonstrating and (even more so) in excluding presence of ADC lesions. In three patients, microembolic foci were only correctly prospectively diagnosed with SENSE DWI, whereas they were obscured by susceptibility artifacts at regular DWI.



45-year-old patient w. callosal infarction. Ssh SE- EPI Diffusion Imaging at 3T **without** SENSE (TR/TE 4463/79 ms)



Same patient as above; ssh Diffusion Imaging at 3T with SENSE, TR/TE 3003/69 ms. Note substantially reduced image distortions in posterior fossa, temporo-basal and fronto-polar region. Note lesion conspicuity is maintained

Conclusion: Diffusion imaging with a SENSE factor of 3 is feasible at 3T. The reduced echo train length of DWI with SF 3 causes a substantial and significant reduction of image artifacts. This translates into a significantly higher confidence in demonstrating or excluding ADC lesions. Our results indicate that SENSE DWI may help improve the sensitivity and specificity of 3T-DWI , in particular in regions close to tissue interfaces.